DOCUMENT RESUME

ED 059 276 TM 001 097

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TITLE Investigations into the Instructional Process: III. P-technique Treatment of Observation Data.
INSTITUTION Helsinki Univ. (Finland). Inst. of Education.
REPORT NO RB-28
PUB DATE Jan 71
NOTE 57p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Factor Analysis; Factor Structure; *Grouping Procedures; Interaction Process Analysis; Observation; Research Design; *Research Methodology; *Research Tools; Statistical Data; *Statistical Studies; Validity
IDENTIFIERS *P technique

ABSTRACT

This paper examines interaction in a school class through the factor-analytical P-technique, considers the behavior of the factor scores in combination with certain other variables included in the interaction matrix, explores the formation of homogeneous groups of lessons in a grouping analysis based on the factor scores, and compares this latter grouping with one previously carried out by means of the O-technique. Statistical analysis of the factor scoring is included. (AG)

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Contents:

1. Introduction 2
2. Objects of the Study 2
3. On the Concept of Validity 3
4. Application of the Factor Analytical P-technique to the Interaction Matrix 5
   4.1. Factor Analysis as a Method of Analyzing a Process 5
   4.2. Selection of the Variables 12
   4.3. Factoring and the Principles of Interpretation 14
5. Results 16
6. Combined Analysis of the Factor Scores and Some Other Variables Obtained from the Interaction Matrix 26
7. Grouping Analysis Based on the Factor Scores . 31
8. A Comment on Subject-specificity 33

References 37

Appendix 1. The Category System
Appendix 2. Phases of the First Factor Analysis
Appendix 3. Phases of the Second Factor Analysis

Investigations into the Instructional Process

III P-technique Treatment of Observational Data

1. Introduction

This report is a sequel to two previous ones (Koskenniemi & Komulainen 1969 and Komulainen 1970a) published in this series. The set of data dealt with here is the same as in the other two reports. In the analysis of 25 videotaped lessons, use was made of a modification of Flanders's interaction analysis technique (Appendix 1). The study was concerned with the work of one school class, which had been followed by means of a closed-circuit television system (see Koskenniemi & Komulainen & Falck 1969).

2. Objects of the Study

The objects of the study included the following:

1) to examine interaction in a school class by means of the factor-analytical P-technique;
2) to consider the behaviour of the emerging factors (factor scores) in combination with certain other variables included in the interaction matrix; and
3) to explore the formation of homogeneous groups of lessons in a grouping analysis based on the factor scores and to compare this grouping with the one previously carried out by means of the O-technique (Koskenniemi & Komulainen 1969).

3. On the Concept of Validity

The writer has previously carried out a small-scale empirical study of a particular special problem associated with the question of generalizability, viz., the problem of the disturbing effects of observation on the work of a school class (Komulainen 1968, 64-68). It was found that the disturbing influence of an internal television system declined in about three weeks to a level from which it did not decrease any more.

The number of cases investigated in the present study was one. The study can be regarded as a case study of the follow-up type. Generalization of the results obtained with such a research design presents difficulties. Because of the laboratory conditions, the situation may prove unique, and this may have unpredictable effects on the behaviour of the school class and/or on that of the individual pupil. The problems associated with generalizability have been discussed by the present writer in another context (Komulainen 1970b), starting from the validity concept suggested by Bracht & Glass (1968). It can be stated as a general observation that, regarding general intelligence and school achievement, the class in question represented an ordinary level as compared with the norms for the whole country and that the same was true of the respective standard deviations. Likewise, the i/d and I/D ratios, as computed lesson by lesson, did not suggest that the class would have been representative of either extreme as regards the teachers' manner of influence.

A further question associated with the problem of representativeness relates to the extent to which the sample of lessons represents the interaction taking place in the school class concerned. Many interaction situations - e.g., those in lessons of physical education, drawing and handicrafts - cannot be analysed by means of the observation methods employed here. Either the non-verbal character of the situations or group work presents difficulties. In this sense the sample can be regarded as biased. Another question associated with sampling is concerned with the

construction of the variables. In this respect the approach chosen here is comparable to the one that Snow (1968) characterized as Brunswikian. In the case of any situation, an attempt is made to obtain a sample ensuring that the variables will vary in a natural way. The variables to be considered are not chosen by means of sampling but are constructed on the basis of some theoretical considerations. Hence, the validity of the variables should be examined from the point of view of the construct validity of Flanders's theory. Interesting from the point of view of validity will then be how the variables employed will get organized so as to describe a given group of instructional events (e.g., as classified according to the school subject), i.e., what instructional process types can be found or what kinds of shorter periods in the instructional process can be identified. One and the same set of data can be analysed by employing a variety of techniques (factor analysis, free description, second-order Markov chains), and an effort can be made to discover what relevant features about the same data are revealed by various approaches. A report on the application of the O-technique to the interaction matrix obtained through observation and on the comparison of the results with a description carried out separately has been published previously (Koskenniemi & Komulainen 1969). These two different approaches were found to result in overall pictures similar to each other.

4. Application of the Factor Analytical P-technique to the Interaction Matrix

4.1. Factor Analysis as a Method of Analysing a Process

McGrath & Altman wrote (1966, 72): "One of the major operational parameters used in the classification system - and one which is apparently of consequence, empirically - is the mode distinction between state and action, or structure and process. This distinction is essentially in the temporal dimension; structure implies a static temporal referent, process implies movement or change through time. ... Temporal relationships of at least three kinds are of concern in small group research: (1) temporal aspects of the group's pre-study history; (2) directional changes in the group through time - 'between sessions' pattern of group development; and (3) phasis, cyclical, or sequential fluctuations in group activity through time - 'within sessions' patterns of group process." What applies to small group research also applies to the study of instruction: when instruction is considered as a process, this in itself implies that the time factor must be taken into consideration in the research model (Koskenniemi 1968, 205).

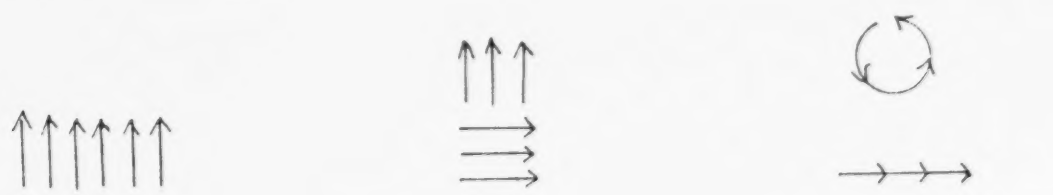
This requirement is, however, very difficult to satisfy. The statistical methods at our disposal are structure-centred. Bellack solved the problem by defining the most general combinations of elementary factors that formed a second-order unit or cycle (Bellack & Kliebard 1966). Many similar attempts have been made by other investigators (e.g., the "teaching module" approach by McNaughton & al. 1967). They presuppose, however, that both the beginning and end of the sequence of events chosen as the second-order unit can be accurately identified. The other means tried out to solve the problem include various pattern-type approaches (Nuthall 1966; Fuller & al. 1968; Urbach 1968). The principal merit of these methods is their quickness. A quick method is called for in the feedback situations met in practice, but these techniques are not suitable for research purposes.

Factor analysis has traditionally been regarded as a means fit for the study of the structure of the conditions prevailing at the time of measurement (Vahervuo & Ahmavaara 1958, 176). Thus, the use of factor analysis is generally considered to involve the assumption that what is investigated is, in one sense or another, static in character. As I see it, this has been due to different reasons. The techniques of dynamic factor analysis have been neither known nor used. This, in turn, has partly been because it is often impossible for us to carry out repeated, mutually independent measurements on the same variables. Learning, fatigue and other similar factors associated with the measurement situation give rise to disturbances in measurement, manifesting themselves either in the form of systematic trends or as changes in validity. However, in recent years a number of investigations have been published in which factor analysis has been employed in the study of process-like change phenomena (e.g., Riihinen 1965).

In the studies concerned, a process has been understood as a sequence of events or as a change in which no clear cause - effect relationships are indentifiable from the primary data. A given change comes into being as a result of interaction or accumulation. In factor analysis this manifests itself in such a way that the interacting entities (variables) obtain high loadings on the same factor. The structure of the variables consequently consists of a process. At the interpretational stage, the investigator re-introduces the temporal aspect into the factor when he examines what kinds of intervening mechanisms account for the factor.

The investigator of the instructional process is in a more advantageous position, since during the stage of interpretation he has disposal of both the videotaped original sequence of events and the codings done from it. In the present analysis the material was assumed to include three types of process: (1) sequences common to all lessons, (2) sequences common to given groups of lessons and (3) unique sequences peculiar to a single lesson.

Regarding the application of factor analysis the situation was as follows. A 13 x 13 interaction matrix was available for each of the lessons in the material. Each cell of the matrix was regarded as the result of a single measurement operation. In investigating the sequences common to all lessons, the intercorrelations of the cells were computed over the lessons (N = 25), and the resulting correlation matrix was factor analysed. The factors emerging upon rotation are groupings of connections. This is to say that the connections loaded on any one factor must have appeared near to one another in the course of the instructional process. The original codings and the logic inherent in the connections help to attain a precise process interpretation. The variables are thus steps on a network. Factor analysis groups the steps into clusters, and in interpretation they are formed into a sequence:



It should be pointed out that, when common sequences are spoken of here, this is not meant to imply that the frequency of occurrence of such sequences should be the same in various lessons but merely that they are similar in shape in various lessons, whereas their frequency varies from lesson to lesson.

The general principles underlying factor analysis and its various phases are supposed to be known. Only a few special problems will be discussed, after which the specific area of application of the P-technique will be considered.

The ratio of the number of variables to that of observations is critical to some extent in factor analytical studies. The question involved here reduces, via the standard-error-of-the-correlation concept, to the invariance problem of the number of

factors and the factor structure.

In the present study the correlations were computed from a comparatively small set of observations. Mårdberg holds that there should be at least 2 or 3, and preferably some 10, observations per parameter. This implies that in a factor analysis of 40 variables - which is expected to yield 10 factors - we ought to have some 1 200 observations, in order that inferences could be made from significance testing (Mårdberg 1969, 157). Nunnally's opinion is similar, though less stringent (1967, 355): "Since there are so many opportunities to take advantage of chance in factor analysis ... a good rule is to have at least ten times as many subjects as variables." These requirements are disregarded grossly in the present study. As I see it, however, a more liberal stand can be taken in the matter in cases where factor analysis is employed as a means to obtain a parsimonious preliminary description of a set of data, without making any conclusions as to the exact number of factors or as to the significance of the factor loadings. Such departures from rules are necessary when an effort is made at a preliminary mapping-out of the area to be investigated. The point is, in my opinion, that the investigator proceeding in this way should be aware of the dangers entailed by and the sources of error inherent in the procedure.

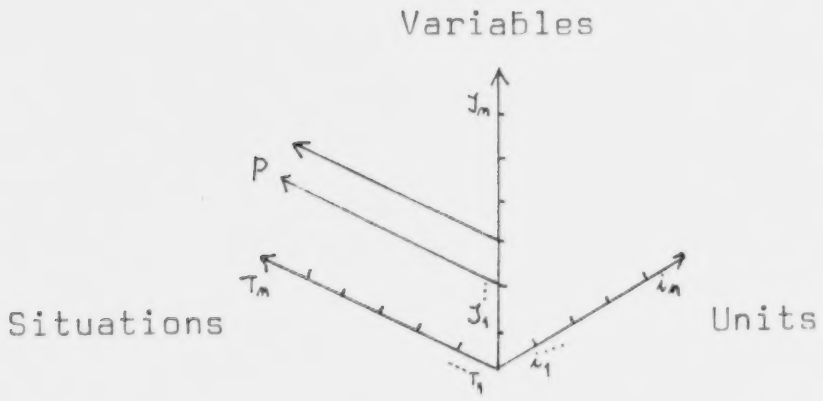
Factor analysis is a linear model. The linearity assumption applies both to the interrelations between the variables and to those between the variables and factors. How far the assumption is tenable is examined rarely, if ever. With the present material the assumption is highly likely to hold true for those variables that represent transitional states. Where transitional states are frequent, it automatically follows that some other state or states are also involved. If the relationships are not completely linear, they in any case meet the requirement of monotonicity. And it is well known that, when the relationships remain monotonic, their departure from linearity is not fatal for the size of the correlation coefficients. The case is different with so-

called steady-state variables (the diagonal cells of the interaction matrix). When the state remains the same, a monotonic increase or decrease need not necessarily take place in any other states. Moreover, the steady-state cells have associations with widely varying sequences. Each of them is a kind of crossroads, from which a variety of routes leads ahead. In this respect their inclusion in a factor analysis is risky. On the other hand, they represent such an important property of the instructional process that their exclusion would have substantially narrowed down the scope of this study. The reason why I don't consider the ipsativeness of the variables to present a particular problem should also be indicated at this point: factor analysis is in fact used here as a means to explore the occurrence of ipsativeness in the present material.

Neither did I regard the skewness of the distributions as troublesome. (Almost all of them were positively skew.) As I see it, the situation only becomes critical when the material includes both positively and negatively skewed distributions. On the other hand, as far as the relationships are monotonic, distributions that are skewed in the same direction do not cause decisive changes in the emerging factor structure.

The P-technique is spoken of where there is only one unit (subject) and several variables on which numerous measurements have been carried out at given intervals. The intercorrelations of the variables as computed over the situations are termed P-correlations.

Figure 1. The P-technique as Represented in Terms of a Covariation Chart (Cattell 1952, 109).



The P-technique was introduced by Cattell, who has demonstrated its use in numerous publications (Cattell & al. 1947; Cattell & Luborsky 1950; Cattell 1952; Cattell 1953). The character of the factors obtained through the P-technique remains indefinite, in a sense. Cattell employs concepts such as "functional unity", "underlying influences" and the "degree of functional connection", which all refer to situations involving mainly physiological variables (Cattell & Williams 1953). The factors obtained by the P-technique are not connected mathematically with those yielded by the R- or Q-techniques. From the empirical studies carried out, however, Cattell concludes that "the evidence so far is that these unique factors turn out to be slightly distorted copies of the patterns of common factors obtained by R-technique" (1952, 105).

Severe criticisms have also been advanced against the P-technique in factor analysis (mainly by Anderson 1963 and Holtzman 1962). The most cogent argument has been that measurements repeated at given intervals are not mutually independent. In the case of observation, the dependence is due mainly to three different circumstances. (1) The pupils get adapted to being observed, and this gives rise to a trend in successive measurements. (2) The coder becomes increasingly experienced in coding or his

proficiency in coding changes from one lesson to another (3) Lessons are not separate events but are interconnected within the framework of some more extensive goal. It seems to me, however, that these drawbacks are minimal; and in the present study at least the coder's influence was eliminated by randomizing the order of coding. Moreover, Cattell feels that it is unnecessary to eliminate from the data a trend that remains constant. Factor analysis disregards the trend factor where such makes its appearance (Cattell 1952, 102).

As I see it, an objection of greater importance is the one concerning the nature of the error term. Rather than being of a random character, coding errors are to a large extent meaningful misconceptions typical of the individual coder. Such meaningful errors tend to accumulate in given sections of the interaction matrix. The effect of this fact is difficult to evaluate. As I see it, however, the effect is unlikely to be notable, considering that reliability proved comparatively high. Anderson has put forward the view that this is no very serious problem in factor analytical studies (Anderson 1963).

No factor analytical studies of the instructional process carried out by means of the P-technique have been published, although a few such studies may be under way. One attempt has been made at the application of this method to the study of group behaviour (Mann 1967). Some Ryans's investigations may have somethig to do with the course of the instructional process, particularly since many of the assessment dimensions used by him reflect the direct-indirect way of influence, underlying Flanders's category system. The rating-type variables set, however, limits to the comparison (Ryans 1952; Ryans & Wandt 1952). Medley & Mitzel have carried out a structure study by means of OScAR 2, with 49 teachers of grades III - VI as their subjects. They found that the variables used could be described in terms of three dimensions: "emotional climate", "verbal emphasis" and "social structure" (1958). Medley & Hill (1969) correlated variables measured by Flanders's method and OScAR 4 V over teachers. They select-

ed variables indicating permanent differences between teachers. Although the study was mainly concerned with the structure, a degree of dynamic content was obtained for the factors. Of their ten varimax factors, four were related to the questions asked or answered, three were descriptive of pupils talk and the teacher's responses to it and another three included information about the way the teacher managed the class-room activity.

Efforts have been made to clarify the interrelations between different taxonomies by means of factor analysis (e.g., Wood, Brown, Ober & Soar 1969).

Some ethologists have analysed animal interaction by methods similar to the one adopted in the present study (see Hutt & Hutt 1970). Wiepkema's investigation (1961) was particularly interesting. Initially he applied factor analysis to the rank-order correlation matrix of the categories. The rank-order correlations concerned were those between the columns of the interaction matrix. Rank-order in each column was based on the relationships between the observed and expected values. Wiepkema succeeded in reconstructing the factors as behavioural sequences, which he later interpreted as manifestations of various motivational systems of the animals.

The application of factor analysis to data obtained through observation is problematic in itself. The criticisms made of it should not be forgotten (see, e.g., Bereiter 1966).

4.2. Selection of the Variables

In principle, the observation matrix ought to be factored in its entirety. The number of variables actually included in factor analysis was restricted, in practice, not only by the capacity of the electronic computers available but also by the following facts: As N was only 25 for the correlations, the inclusion of a very large number of variables was inadvisable. Pairs of events were distributed extremely unevenly between the

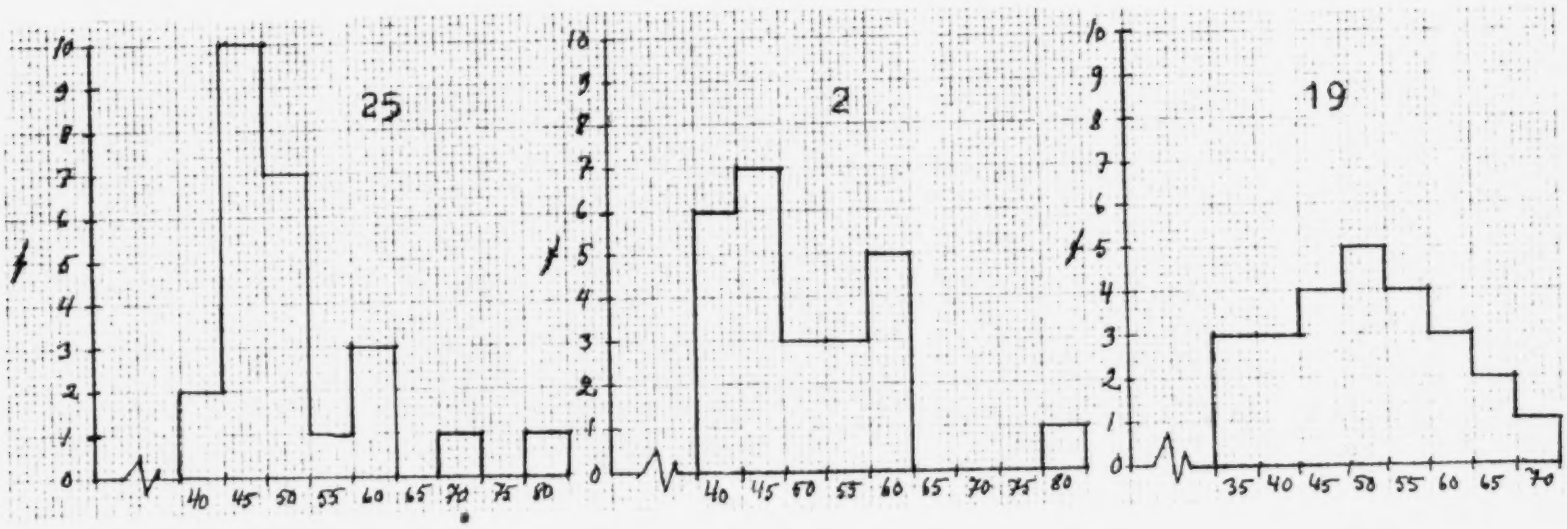
cells of the matrix; and, in consequence, the distributions of the variables for which the frequency was low were bound to remain very skew. There were variables with no dispersion at all. The impact of the coding errors on the variables for which the frequency is low is far greater compared with the other variables. Thus, only 50 cells that were satisfactorily well-behaved statistically were chosen as the variables.

Use of the cells f_{11}, f_{21}, etc. of the interaction matrix I as variables is complicated by the fact that the frequency of observations varies to some extent from one lesson to another. This is mainly because the duration of videotaping is not the same for all lessons. Therefore, the cells of the percentage matrix were employed here as the variables. This normalization operation was based on the assumption that the accumulation of events in the cells takes place in such a way that the ratios between the frequencies remain unchanged.

Figure 2. The Variables Selected for the Study. The code number of each variable is indicated in the relevant cell.

	1	2	3	4a	4b	5	6	7	8	9a	9b	10	Z
1			5	7	13	16	25		35				
2						17							
3			6			18							
4a				8					36			45	
4b					14				37				
5				9	15	19	26	31	38	42		46	
6				10		20	27	32	39			47	
7						21	28	33				48	
8	1	3		11		22	29		40			49	
9a	2	4				23				43			
9b													
10				12		24	30	34	41	44		50	
Z													

Figure 3. Some Typical Distributions, as Transformed into T Scores



4.3. Factoring and the Principles of Interpretation

The intercorrelation matrix was obtained by correlating the cells over the lessons. The correlation matrix was factored by the principal axis method, and the numerically highest correlations were used as the estimates of h^2. Rotation was carried out by the orthogonal varimax technique. This rotation method was chosen, because it, being orthogonal, was likely to yield a simple and clear-cut result useful at the initial stage of an investigation. The number of factors to be rotated was determined according to the principle that it is preferable to include too many than too few factors, and that a description that is optimal both interpretationally and in terms of the simple structure rule should then be sought through successive reductions of the primary base (Markkanen 1963). In the present case, the object of the study and interpretability of the results were the primary determinants of decisions. The number of factors initially chosen was N + 1, where N was the number of factors for which the eigenvalue exceeded 1.0.

Interpretation here means that the variables loaded on any one factor are constructed into a sequence. The factor loadings of the cells and the regression coefficients obtained by them in the estimation of factor scores help to identify the cells that are central in the sequence of the factor in question. In addition, use was made of the information obtained by comparing the lessons for which the factor scores were the highest with those with the lowest factor scores. The p values of the routes can be examined by employing the second-order transition probabilities to be presented in a later report.

5. Results

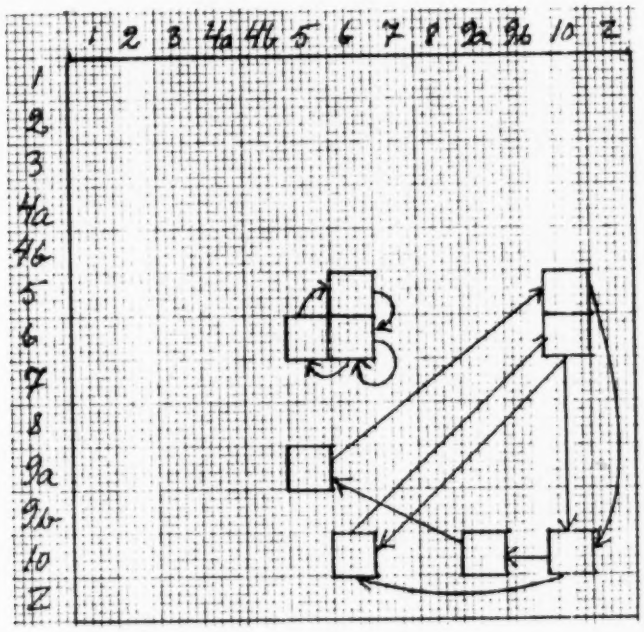
In reporting the results of this study, use will be made of the flow-chart description (Flanders 1967, 362-368). It corresponds to the mode of description formerly called network. The cells are states and arrows represent transition from one state to another. It was necessary here to interpret the two poles of each factor separately. This state of affairs is attributable to the use of a taxonomy. As the system is always in some state, an increase in any one form of behaviour leads, of course, to a decrease in the other forms.

No attempt will be made below to verbalize the content of the sequences. As I see it, the content of each sequence will become clear enough in the analysis of factor scores and, in a later report, from the second-order Markov probabilities. In the case of each sequence, the cells whose loadings were the highest will be indicated. It should be borne in mind, however, that other information was also utilized in interpretation.

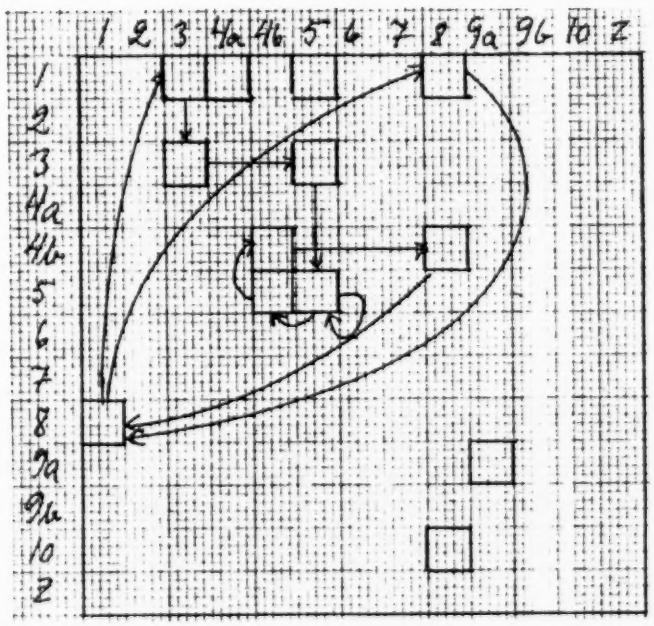
Factor I:

Positive pole		Negative pole	
6 - 5	.49	8 - 1	-.88
9a- 5	.59	1 - 3	-.71
5 - 6	.63	3 - 3	-.71
6 - 6	.81	1 - 4a	-.70
10 - 6	.70	4b- 4b	-.61
10 - 9a	.50	5 - 4b	-.74
5 -10	.40	1 - 5	-.41
6 -10	.76	3 - 5	-.67
10 -10	.73	5 - 5	-.54
		1 - 8	-.68
		4b- 8	-.45
		10 - 8	-.71
		9a- 9a	-.43

Figure 4. The Factor I Sequences.



(a) Positive Pole



(b) Negative Pole

The sequences of the factor are represented in figure 4. The positive-pole activities consist of directions, orders and lecturing, and of silence interspersed among these types of activity. Characteristic of the negative-pole activities are information, comprehensive questions, positive reactions to the pupil talk and utilization of ideas put forward by pupils.

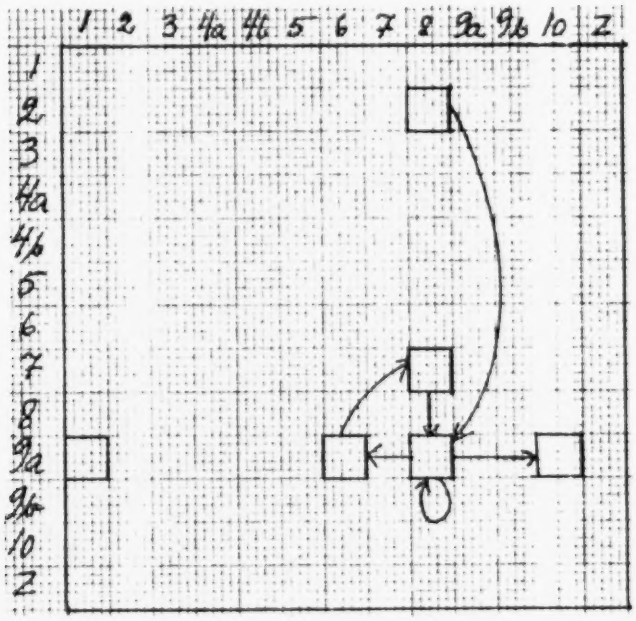
Factor II:	Positive pole		Negative pole
8 - 2	.57	10 - 4a	-.72
8 - 6	.44	9a- 5	-.52
6 - 8	.57	10 - 5	-.82
8 - 8	.59	10 - 7	-.64
8 -10	.42	10 - 9a	-.51
		4a-10	-.92
		5 -10	-.72
		7 -10	-.81

The sequences typical of this factor are represented in Figure 5. The positive pole has to do with a sequence formed by directions and answers (observation of directions), while the negative pole is associated with situations where silence and individual guidance predominate.

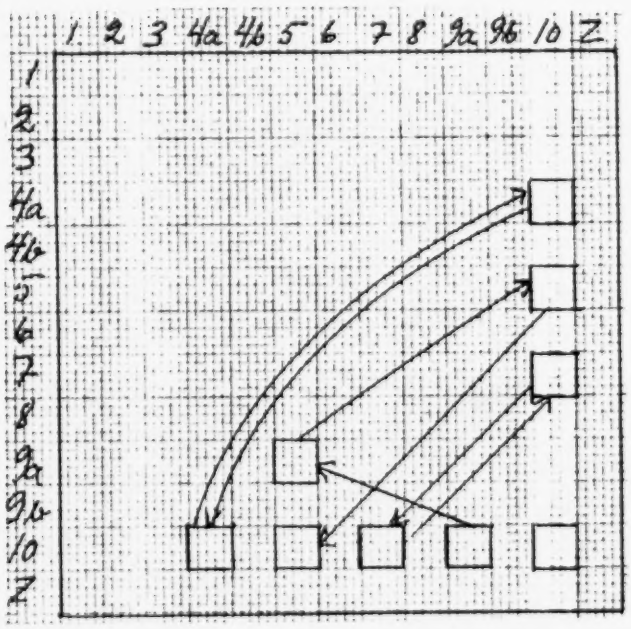
Factor III:	Positive pole		Negative pole
9a- 2	.42	5 - 4a	-.66
7 - 6	.66	3 - 5	-.46
8 - 6	.42	5 - 5	-.44
5 - 7	.52		
6 - 7	.75		
7 - 7	.70		
10 - 7	.49		
6 - 8	.47		
8 - 8	.47		

The relevant sequences are represented in Figure 6. The positive-pole behaviours are activities typified by what

Figure 5. The Factor II Sequences

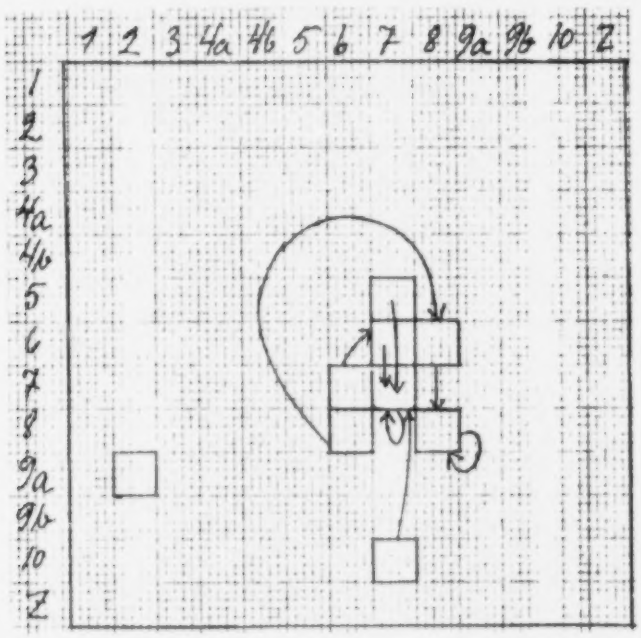


(a) Positive Pole

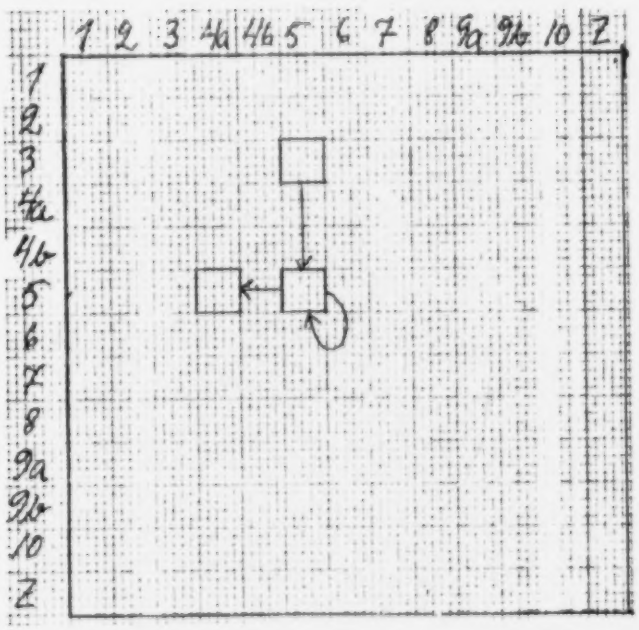


(b) Negative Pole

Figure 6. The Factor III Sequences



(a) Positive Pole



(b) Negative Pole

Flanders calls a "vicious circle" (1965, 39). Such a circle of criticisms is initiated by resistance on the part of the pupils or by the fact that too much is demanded from them. The negative-pole activities reveal no distinct pattern.

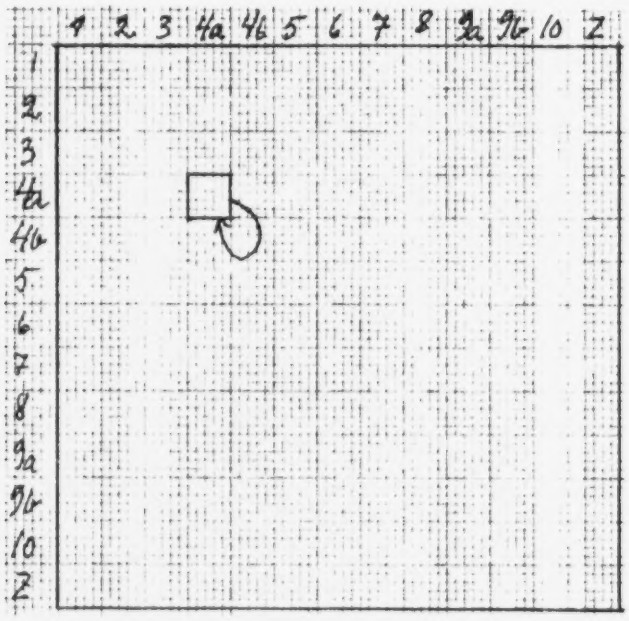
Factor IV:	Positive pole	Negative pole
4a- 4a	.42	1 - 5 -.44
		2 - 5 -.67
		7 - 5 -.70
		5 - 6 -.43
		4a- 8 -.46
		5 - 9a -.40

The sequences are represented in Figure 7. The positive-pole is hard to characterize. The negative-pole activities are connected with the beginning and termination of the teacher's presentation, but what happens in the sequel remains rather unclear.

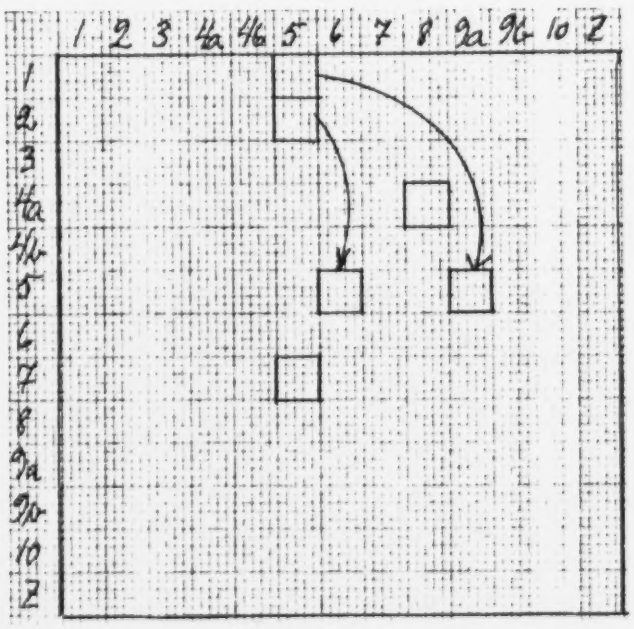
Factor V:	Positive pole	Negative pole
9a- 2	.55	9a- 1 -.68
6 - 4a	.51	3 - 3 -.46
1 - 6	.40	1 - 4b -.65
8 - 6	.55	5 - 5 -.54
4a- 8	.63	4b- 8 -.43
6 - 8	.54	
8 -10	.53	

The sequences are represented in Figure 8. The factor is diffuse in content. The positive-pole has to do mainly with behaviours restraining pupils' activity, whereas the negative-pole is typified by questions stimulating pupils' thinking, by acceptance of their spontaneous activity and by utilization of it.

Figure 7. The Factor IV Sequences

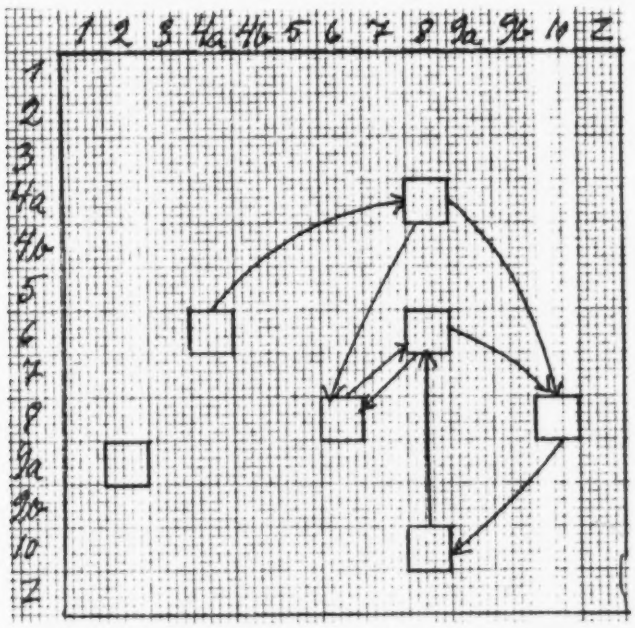


(a) Positive Pole

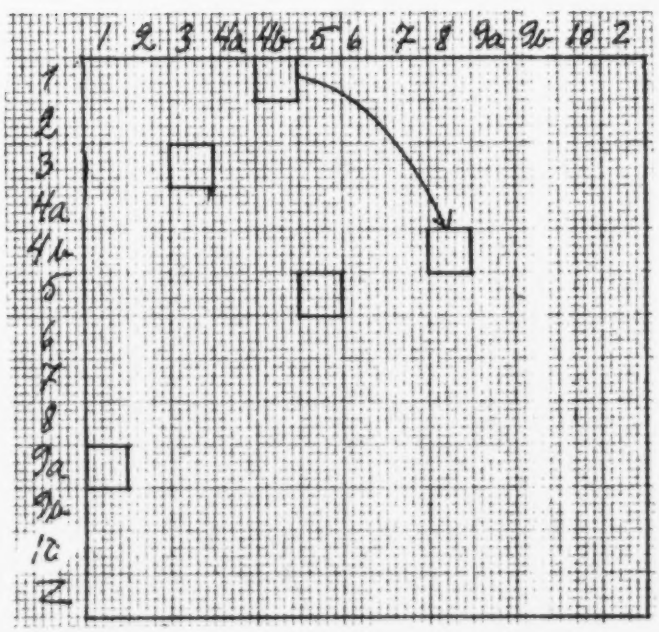


(b) Negative Pole

Figure 8. The Factor V Sequences

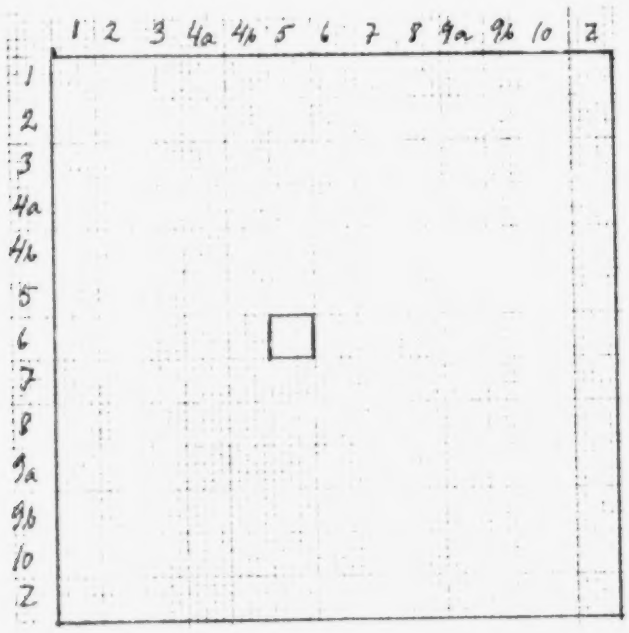


(a) Positive Pole

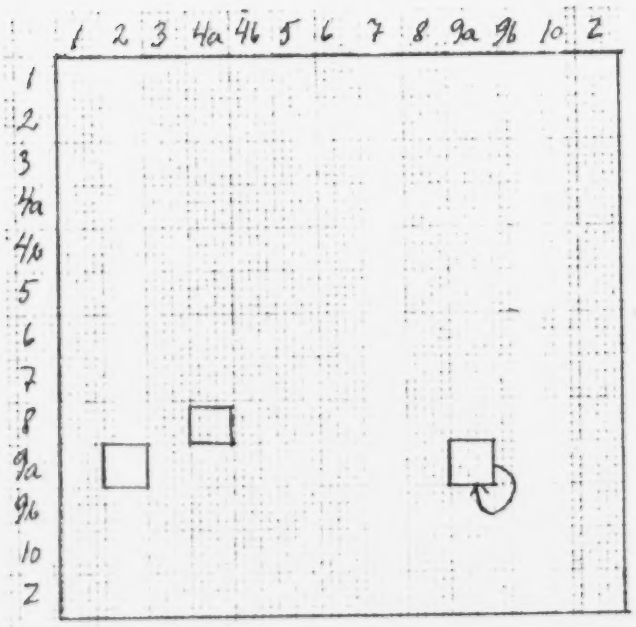


(b) Negative Pole

Figure 9. The Factor VI Sequences



(a) Positive Pole



(b) Negative Pole

Factor VI:	Positive pole		Negative pole
6 - 5	.43	8 - 4a	-.61
5 - 8	.42	9a- 9a	-.67

The sequences are represented in Figure 9. These are fragmentary, and it seems to me that they are of little importance.

Two features, in particular, seem to be clearly characteristic of the sequences found. The teacher's way of influencing the pupils is distinctly in evidence in several dimensions. However, the differentiation of this way of influencing supports the views of those authors who have criticized the unidimensionality of the i/d ratio. Decisive is which of the cells constituting the i/d ratio are meant. Another circumstance with a bearing on the sequences is the pupils' spontaneous activity. Yet the significance of this point also varies depending on the type of activity aimed at: questions, suggestions or criticisms.

6. Combined Analysis of the Factor Scores and Some Other Variables Obtained from the Interaction Matrix

Factor analysis is generally not continued beyond the determination and description of a structure. Because of the object of the present study, however, further questions arise: What do the factors measure? Do they have associations with the interpretation areas obtained on an a priori basis from the interaction matrix (Flanders 1965)? The factor score estimates provide, moreover, information about the distinctness of the factor structure (Überla 1968). However, the following fact makes the computation of correlations between factor scores and other matrix indices problematic: they are technically interdependent to a varying extent, and in consequence, considerable spurious correlations are likely to emerge (see McNemar 1962, 162-163). Nevertheless, factor analysis will be used here to furnish a parsimonious description of the information contained in the correlation matrix.

A total of 37 variables were included in the analysis. Variables 1 - 6 were factor scores and variables 7 - 19 were column sums of the interaction matrix. The interpretation-area variables are listed below:

Variable	
20	The teacher's I-reaction to pupil talk (indirect, extending the pupil's freedom of action)
21	The teacher's D-reaction to pupil talk (direct, restricting the pupil's freedom of action)
22	Pupil talk in response to teacher talk
23	The diagonal of the matrix or a steady state
24	Accentuated i-region (constructive integration)
25	Content cross
26	Vicious circle
27	Prolonged pupil talk

Variables 28 - 36 consisted of relationships descriptive of the way of influencing.

Variable	
28	Total i-area
29	Total I-area
30	Total d-area
31	Total D-area
32	The i/d ratio
33	The I/D ratio
34	Total S-area (the pupil's participation)
35	Total T-area (the teacher's participation)
36	The S/T ratio

Variable 37 was obtained by finding the number of empty cells in the interaction matrix of each lesson. The smaller the number of empty cells, the more varied had the interaction been. This is a measure of flexibility (Bondi 1969).

The correlation matrix was factored by means of the principal axis method, the numerically highest correlations being used as the h^2 estimates. The varimax technique was employed in rotation. Six factors were included in the rotational solution, since it seemed that the factors were located, in accordance with expectations, near the mutually independent factor score variables.

The factors obtained will be characterized below.

Factor I: Variable	Loading
1	.93
13	.83
18	.71
21	.77
26	.75
30	.78
7	-.92
9	-.91
11	-.82
20	-.84
24	-.88
28	-.96
29	-.93
32	-.88
33	-.77
35	-.74

The first factor was clear-cut in content. The factor score representing the first sequence obtained a high positive loading on it. The most important of the variables with negative loadings was variable 28 (i), descriptive of the entire indirect-influence area. The dimension can be named an indirect - direct behaviour dimension. The criticism category was the only category-system sum-score variable that did not behave as expected (loading .24). On the other hand, the vicious circle variable (variable 26) had a loading equal to .75 on this factor. Particularly the context in which criticism occurs obviously bears on its significance.

Factor II:	Variable	Loading
	10	.56
	25	.62
	2	-.74
	15	-.97
	27	-.96
	34	-.97
	36	-.93

Here, all the most important loadings were negative. The loadings were spuriously high. The second sequence had a high loading on this factor. The other variables with the highest loadings were also related to pupil talk. Spontaneous participation (variable 16) did not obtain a loading. This dimension appeared to be, roughly speaking, one of reactive pupil activity.

Factor III:	Variable	Loading
	4	.78
	19	.64
	22	.66

The content of this factor was not very clear. The highest of the positive loadings was that of the fourth sequence. As was pointed out previously, this sequence was of an indefinite character. Of the interpretation areas, the steady-state variable had the highest loading, and the category that obtained the highest loading was confused situation. I strongly suspect that this factor was technical in nature.

Factor IV:	Variable	Loading
	6	.86
	8	-.47
	16	-.72

The fourth factor was related to spontaneous pupil activity. The sixth sequence, which consisted particularly of prolonged spontaneous activities, was loaded on the factor, and this clearly refers to the pupils' suggestive rather than to their questioning activity. The loading of corrective feedback obviously had to do with criticisms made by the teacher of the pupils' suggestions. The dimension reflected spontaneous pupil activity.

Factor V:	Variable	Loading
	3	-.78
	14	-.78

This was a criticism factor. The third sequence, which was interpreted as "vicious circle" activity, and the criticism category were the most important variables. The interpretation area corresponding to them also had a loading -.46.

Factor VI:	Variable	Loading
	5	.71
	10	.67
	23	-.47
	31	-.49

The sixth factor was a questioning factor. The most important type of activity in the fifth sequence, loaded on this factor, was representative of question - answer behaviour. The absence of pupil activity is due to the fact that, in "drill", answers tend to be short, consisting of one word or two.

Consideration of the communalities of the variables revealed that variables 17, 19 and 37 did not correlate with the other variables. Variables 17 (9b) and 19 (Z) in fact relate to behaviours that are encountered extremely rarely in teaching situations.

Both represent disturbances in the instructional process. Thus it was only natural for them to remain separate from other kinds of behaviour. But why, then, did the flexibility variable (37) not behave in the expected manner? At the least, a considerably high negative correlation could have been expected to emerge with the steady-state variable, since these two variables apparently represent opposites of one other. Yet the correlation between them was positive, though low (.23). The explanation obviously lies in the following fact referred to in connection with the analysis of reliability (Komulainen 1970a): the cells of the matrix are notably more susceptible to chance factors than are the categories. Even a single observation in a cell causes a change in the flexibility variable.

7. Grouping Analysis Based on the Factor Scores

In the preceding chapter the factor scores estimated for the sequences were considered together with other variables obtained from the interaction matrix. These factor scores can, however, also be employed alone, in a comparative analysis of the lessons.

In a previous context, O-type factor analysis was used to group the lessons on the basis of the sequences (Koskenniemi & Komulainen 1969). Factor scores provide alternative possibilities for such an analysis. One of them is grouping analysis. Here, use was made of HYLPGA 1969.[1)] The HYLPGA classifies a heterogeneous material into homogeneous groups on the basis of factor scores. Grouping analysis differs from discriminant analysis, in that the groups are not known in advance. The goal is to form such groups that, for each of them, the sum of the distances from the group mean of the observations, will be a minimum. The number of groups must be decided on in advance. In one and the same run, several groupings of the same data can be performed and groupings can be carried out with various initial values. Depending on the initial values, the emerging grouping may vary to some extent.

Here, the object was to compare the results of a grouping analysis with those previously obtained through O-technique analysis (Koskenniemi & Komulainen 1969). To this end, 5 to 8 groups were employed in the grouping analysis: O-analysis had yielded eight groups and experts had classified the lessons into five activity types. All the HYLPGA groupings were repeated with three different initial values.

Before reporting the results, it should be stated that the grouping analysis performed proved disappointing: the result depended to an excessive extent on the initial values. The classifications into five groups with different initial values are cross-tabulated in the following table.

---

1) The University of Helsinki Computer Centre Program for Grouping Analysis.

Table 1. Classifications into Five Groups

1.

	1	2	3	4	5
1	1				2
2		2	2	1	1
3	2		4		
4	1				1
5	1	1	1	1	4

2.

	1	2	3	4	5
1	1			1	1
2		3	2	1	
3		2	4		
4	2				
5		2	1		5

3.

	1	2	3	4	5
1	3				4
2	1	2			2
3		1	5	2	
4	2				
5	1		1		1

The result indicates that rather less than half of all the lessons fell within the same groups in successive analyses (diagonal).

Cross-tabulations with the classifications carried out by experts produce a rather diffuse general impression. Activity type I (Lecture & Discussion & Questioning) only behaved fairly uniformly in the comparison.

No comparison with the results of the O-technique analysis was possible: the 8 x 8 table was too thin to produce any general impression.

The grouping program yields the means of the factor scores for the groups obtained (the group centroids) and indicates what lessons belong to each particular group. As I see it, however, this is not enough. It would be imperative for us to have a knowledge of the distances of lessons from the centroids of their own groups and from those of the other groups (e.g., in terms of D index distance matrices). The treatment of mixed forms and borderline cases would then be rendered notably more natural. In its present form the program is not suitable for this kind of research purposes.

Table 2. Cross-tabulation with Experts

	I	II	III	IV	V
1	2	1			
2	1	1	1	2	1
3	4	1			1
4	2				
5	1		3	2	2

2.

	I	II	III	IV	V
1	1	2			2
2			2	1	
3	5	1	1		
4				2	
5	4		1	1	2

3.

	I	II	III	IV	V
1	2	1			
2	2	1	2		2
3	3	1		3	
4	1				1
5	2		2	1	1

8. A Comment on Subject-specificity

A multitude of factors are associated with the teaching situation. Not even the most important among them have yet been dealt with at the empirical level within the framework of any model. In the set of lessons considered in the present study, there seemed to be two principal sources of variance: the teacher and the subject matter - and a third one perhaps consisted in the interaction between them. Such a grouping is, however, too narrow and too short-sighted. The inward arrangement of a lesson into phases, the frame of reference furnished by a broader goal period and a variety of other factors all contribute to the explanation of the differences between lessons. When several of the sources of variance are kept constant, certain chance factors will obtain accentuated significance. One such factor is constituted by absences from school. When some active pupil wont to put forward his own ideas, is absent, substantial changes in the teaching situation are likely to ensue. Only by means of carefully designed analyses of variance can the effects of various factors and their interactions be evaluated.

In the present study an attempt was made to explore the significance of the school subject by considering both the results of grouping analysis and factor scores. As was stated in the preceding chapter, the results of grouping analysis depend greatly on the initial values, and thus, too much reliance cannot be placed on its results. There were four school subjects, and therefore a grouping analysis into four groups was carried out by employing three different initial values. The results remained rather indistinct.

Table 3. Grouping Analysis and School Subjects

	R	C	A	F
1	3			4
2	3		2	
3			3	
4	4	4		1

	R	C	A	F
1	3	1	1	3
2	2		3	2
3	3	2	1	
4	2	2		

	R	C	A	F
1	1	2		1
2		2	1	2
3	1	1	4	
4	8			2

In the case of religion and arithmetic, homogeneous group formation seems to be weak, but this view is merely based on a general impression. Religion and civics fall, more or less, in the same groups.

The results about factor scores are illustrated in Figures 10 - 15. It would seem that there are some differences between the school subjects as regards both level and dispersion. In considering the differences in the range of variation between the different subjects, it should be borne in mind that this statistic is particularly sensitive to the effects of chance factors. The figures illustrate the variations through time in the factor scores for the school subjects considered.

Figure 10. The First-Sequence Factor Scores, by School Subjects

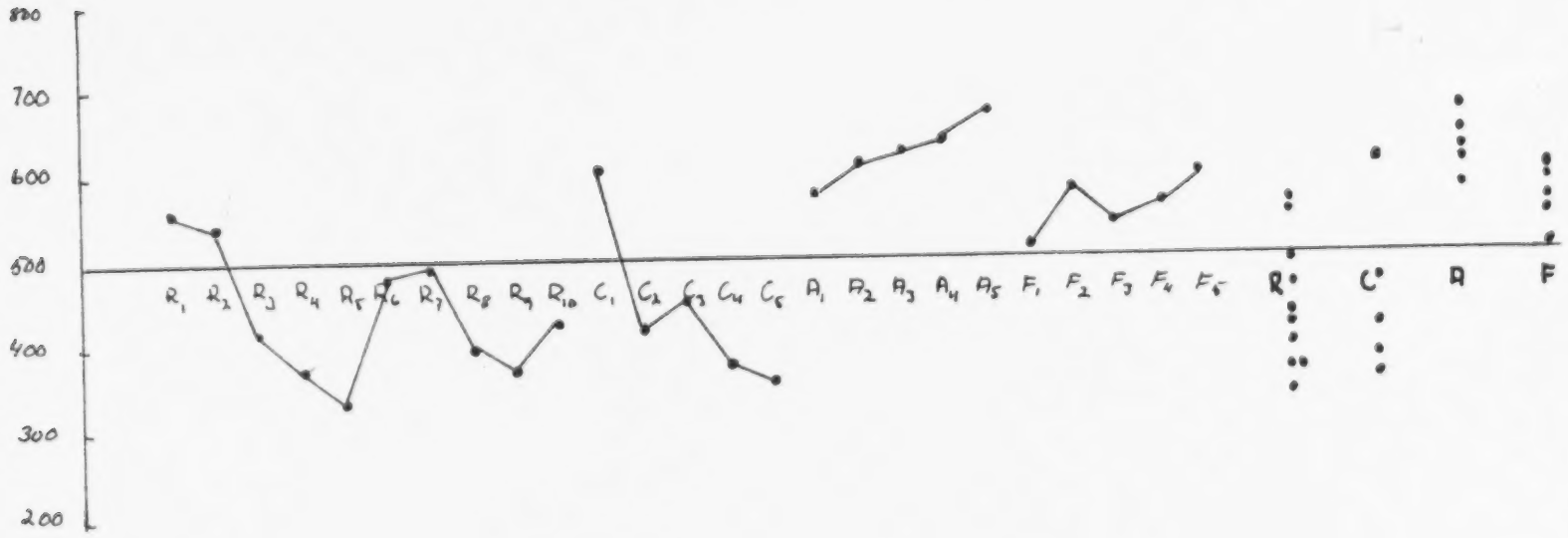


Figure 11. The Second-Sequence Factor Scores, by School Subjects

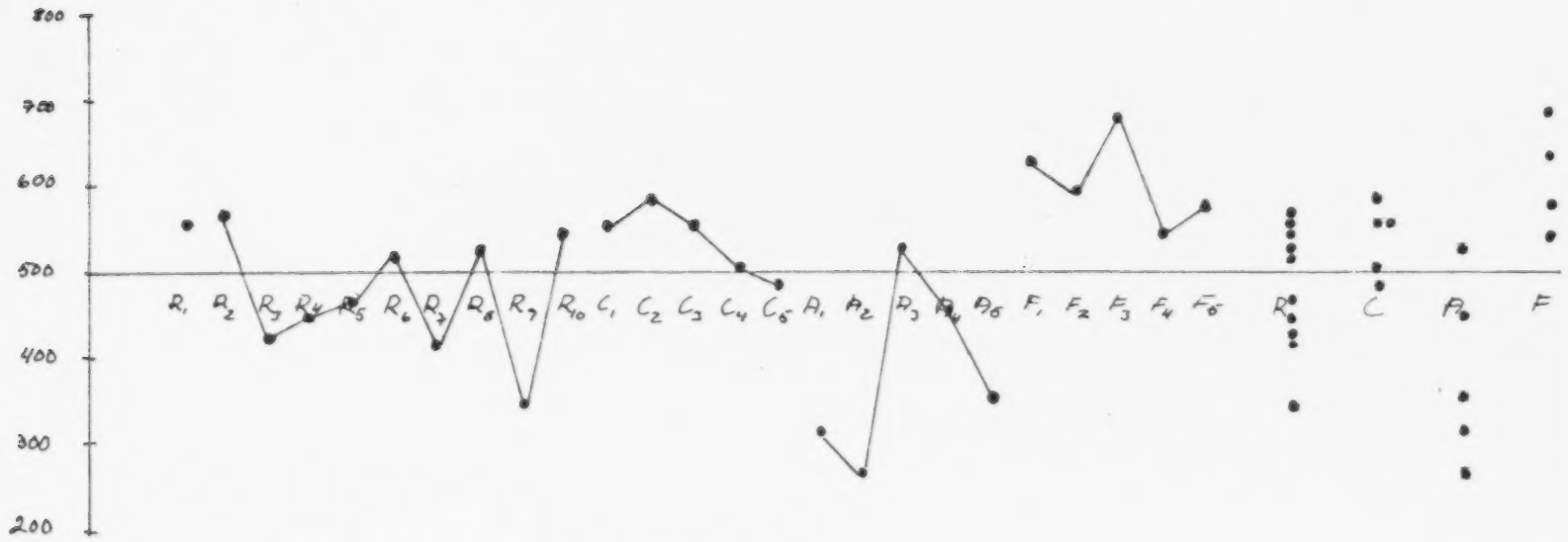


Figure 12. The Third-Sequence Factor Scores, by School Subjects

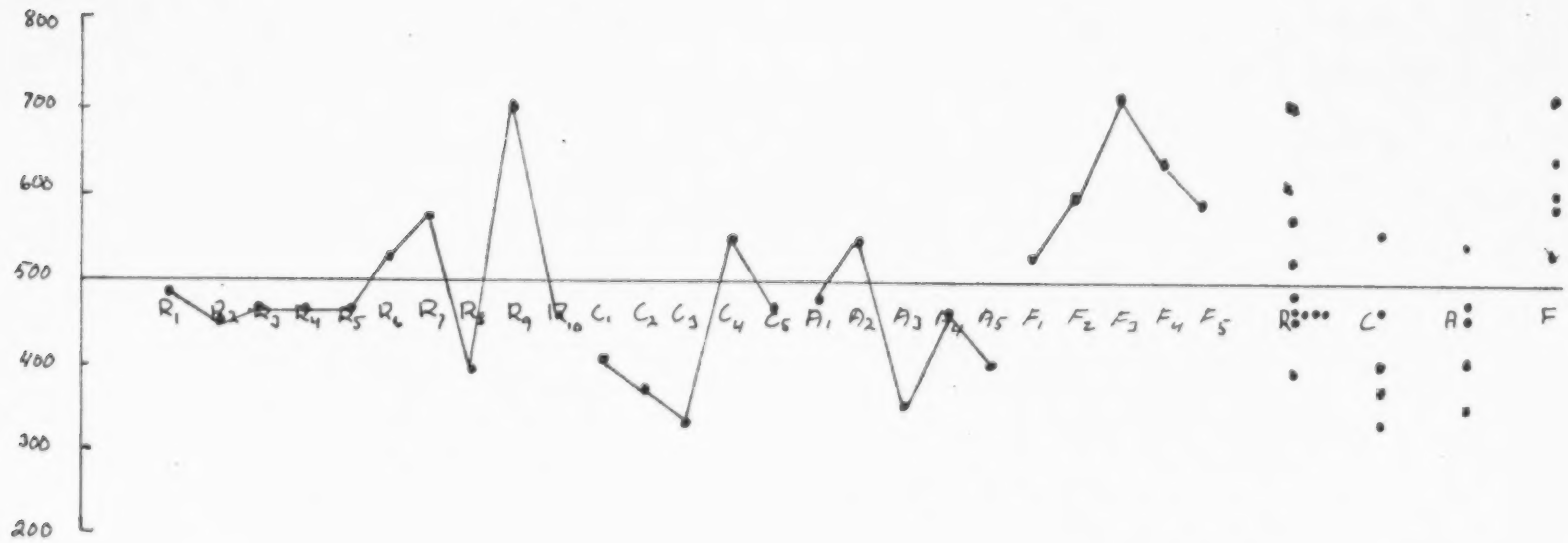


Figure 13. The Fourth-Sequence Factor Scores, by School Subjects

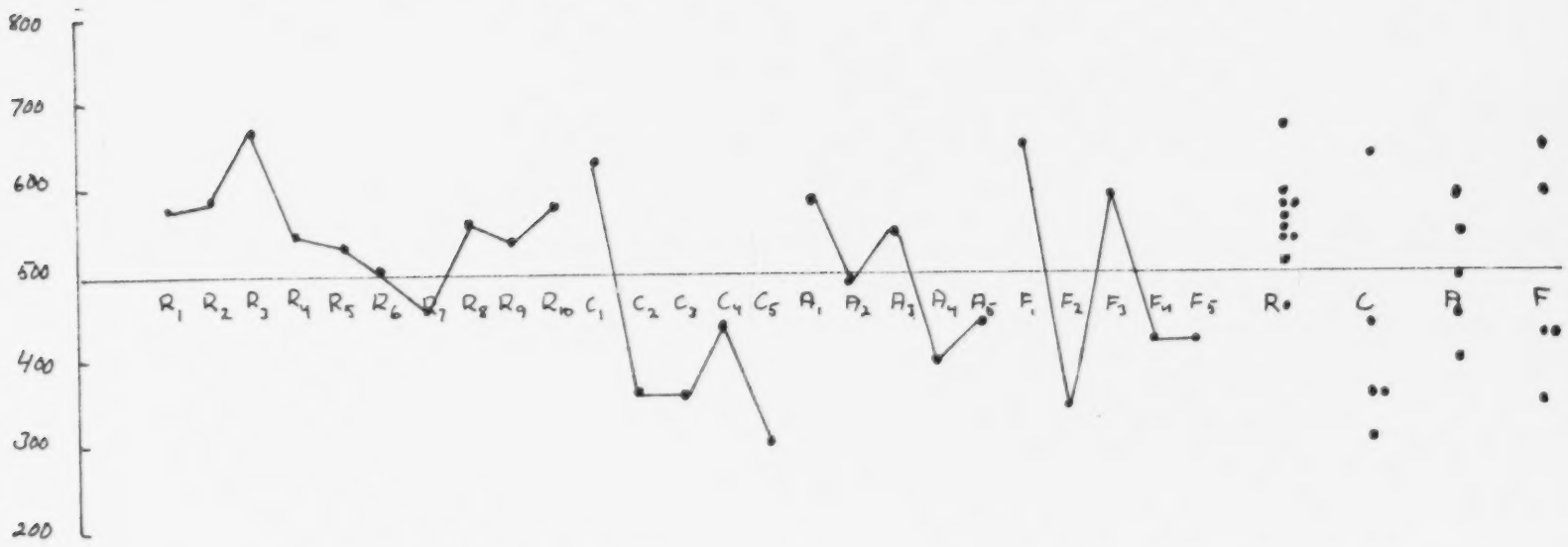


Figure 14. The Fifth-Sequence Factor Scores, by School Subjects

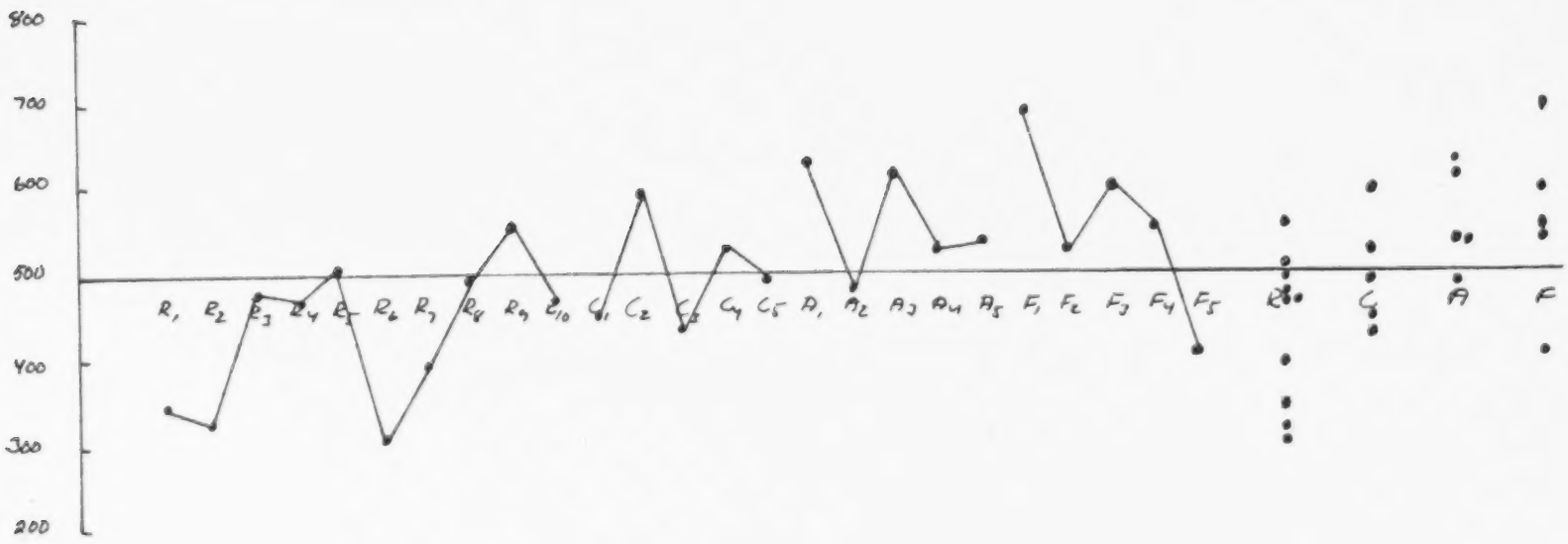
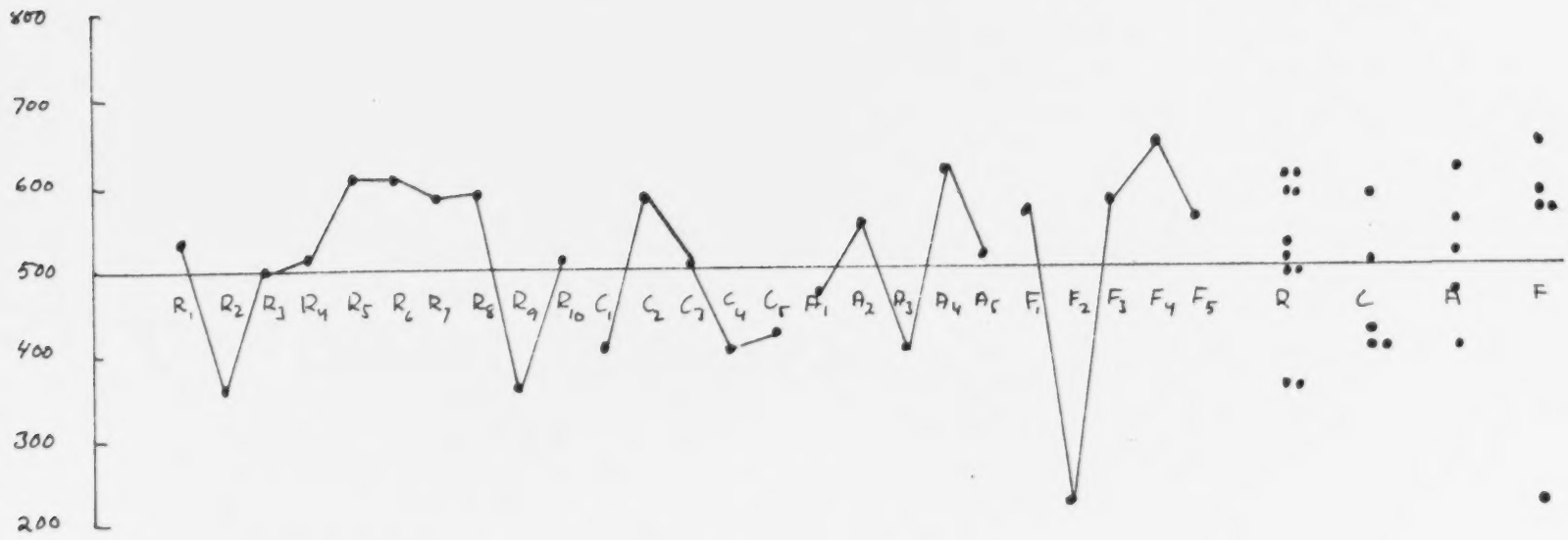


Figure 15. The Sixth-Sequence Factor Scores, by School Subjects



The differences between the school subjects were clearest in the case of the first three sequences; Finnish and arithmetic, in particular, differed from each other quite definitely. A low first-factor score means a predominance of behaviours extending the pupil's freedom of activity. A high second-factor score was indicative of an accentuated part played by reactive pupil activity. Finally, a high third-factor score indicated a frequent occurrence of vicious circle situations. It seems natural that religion and civics were similar to each other and that they differed from both arithmetic and Finnish in these respects.

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Appendix 1.

The Employed Classification System

Teacher talk	1 .	Accepts, praises or encourages
	2 .	Corrective feedback
	3 .	Uses pupil ideas
	4a.	Asks narrow questions
	4b.	Asks broad questions
	5 .	Expresses information or own opinions
	6 .	Gives directions
	7 .	Criticizes pupil behaviour
Pupil talk	8 .	Answers to a question
	9a.	Relevant spontaneous talk and suggestions
	9b.	Irrelevant spontaneous talk
Others	10 .	Silent work, individual work or guidance
	Z .	Tumult, confused situation

50 x 50 Correlation Matrix

Appendix 2.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1																									
2	31																								
3	16	-17																							
4	-21	-34	49																						
5	80	52	02	-42																					
6	70	61	-06	-51	84																				
7	63	29	03	-29	54	54																			
8	19	10	-47	-28	22	16	10																		
9	24	-11	-13	-33	25	14	43	26																	
10	-21	-32	03	37	-11	-18	-03	03	-01																
11	-26	-25	-10	47	-31	-39	-14	16	16	22															
12	-49	-31	-33	-04	-37	-37	-11	-07	08	34	-01														
13	33	51	-18	-43	33	43	07	11	-01	-34	-29	-32													
14	59	28	07	-33	58	57	35	26	31	-05	-22	-37	44												
15	72	29	08	-29	63	71	57	02	49	-16	-29	-32	13	56											
16	43	22	06	00	21	30	44	-05	20	-26	-02	-38	10	25	50										
17	-11	-12	45	39	-21	-25	-03	-28	29	-20	29	-16	-08	03	08	30									
18	66	39	-14	-51	82	84	47	25	44	-24	-18	-35	27	60	76	36	-04								
19	48	48	-28	-55	62	70	25	34	33	-35	-10	-36	46	63	66	24	05	81							
20	-41	-37	20	03	-50	-56	-24	-35	-07	-14	-13	24	-44	-38	-32	03	04	-47	-55						
21	-10	00	40	07	-11	-13	20	-25	13	-16	10	02	-08	02	05	14	38	-09	-12	34					
22	15	-09	03	-08	20	-05	07	03	35	-10	-19	28	02	18	20	15	12	17	08	10	11				
23	-64	-18	-32	-18	-40	-38	-13	-19	22	19	02	57	-17	-53	-31	-40	06	-33	-27	21	06	-02			
24	-18	-28	-40	-24	-11	-14	18	31	18	28	-13	64	-07	-05	-17	-34	-13	-09	-06	-09	-10	-01	46		
25	-24	-24	16	14	-37	-34	-29	-14	-04	37	02	11	-29	-14	-14	-33	-27	-42	-38	43	-04	-08	11	-24	

Appendix 2. (cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	-42	-42	36	37	-44	-56	-39	-60	-11	07	05	24	-14	-41	-37	06	46	-52	-51	46	24	30	29	-16	08
27	-60	-17	05	13	-46	-45	-48	-33	-34	05	10	18	-14	-62	-62	-28	-09	-57	-60	48	18	-14	46	-19	29
28	-06	-19	15	31	-36	-37	-17	-22	-32	-11	35	-14	-15	-33	-27	-02	-06	-37	-36	36	04	-11	-17	-44	51
29	-05	-26	47	46	-25	-25	-08	-28	-35	34	06	-10	-38	-34	-28	-00	-25	-42	-69	43	-04	-24	-25	-35	53
30	-53	-54	03	25	-49	-61	-37	-19	-21	19	21	27	-28	-52	-63	-21	03	-57	-63	41	17	01	46	10	10
31	-13	13	06	09	-31	-10	11	-33	-32	-20	08	-05	13	-04	-01	20	13	-21	-07	24	64	-33	-05	-07	-02
32	-10	-08	21	55	-28	-42	-14	-24	-47	02	33	-19	-03	-27	42	13	23	-39	-40	12	09	02	-13	-30	06
33	-14	01	07	36	-28	-22	-01	-12	-37	24	03	09	-16	-20	-16	-24	-06	-38	-37	13	27	-23	09	09	36
34	-20	14	-25	-00	-08	-16	20	-06	-23	-00	17	52	-11	-29	-33	-17	-10	-19	-22	-08	25	12	22	30	-19
35	73	07	-02	-03	45	44	38	15	-01	02	-18	-29	-05	27	53	30	-31	33	21	-22	-31	-13	-47	-13	09
36	18	-38	30	30	07	-06	40	-05	63	34	43	05	-47	11	34	21	29	13	-12	05	36	15	-02	02	04
37	63	38	14	-45	72	56	34	-02	35	-43	-28	-34	43	45	57	23	06	63	55	-21	16	26	-24	-23	-34
38	35	-13	18	13	02	-06	32	-20	02	-14	-14	-27	-04	-01	11	43	07	-02	-26	14	16	17	-21	-22	01
39	03	-32	62	59	-33	-25	-17	-42	-35	17	02	-19	-26	-24	-12	02	03	-39	-57	33	-04	-19	-32	-42	53
40	03	-14	48	47	-26	-30	-28	-18	-42	03	-20	-34	-10	-17	-22	10	01	-38	-49	36	-16	-04	-34	-40	42
41	70	18	32	07	47	42	49	25	-06	-03	-16	-35	19	38	33	26	-16	26	21	-40	-21	11	-62	-11	-11
42	-18	34	-15	-11	02	05	17	-32	07	-02	-17	22	15	-31	03	02	28	02	00	-11	15	11	60	18	-21
43	25	52	06	13	29	38	35	11	-07	-22	34	-41	20	26	25	19	30	31	47	-58	19	-31	-34	-17	-48
44	-71	-17	-15	28	-62	-59	-19	-13	-06	22	35	54	-43	-40	-43	-39	21	-57	-36	21	27	-11	59	32	22
45	-16	-06	-58	-26	-06	-07	27	34	17	20	04	73	-14	-09	-14	-25	-25	-08	-02	-11	-12	07	43	81	-21
46	-46	-37	-43	-23	-38	-38	-19	14	11	06	-08	76	-20	-28	-34	-43	-11	-29	-18	21	-01	-01	59	82	-11
47	-57	-44	05	18	-47	-55	-43	-22	-10	27	19	22	-34	-50	-53	-16	05	-53	-58	48	24	-05	42	-05	29
48	-25	-12	-45	-03	-16	-23	17	04	-09	32	20	57	-11	-20	-21	-09	-08	-16	-07	-04	14	00	41	61	-20

Appendix 2. (cont.)

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
26																									
27	56																								
28	14	29																							
29	19	34	52																						
30	59	80	17	17																					
31	01	05	27	01	-02																				
32	31	23	66	28	35	24																			
33	-09	11	37	17	13	53	48																		
34	00	07	23	-12	11	34	38	39																	
35	-38	-40	17	10	-29	-08	02	16	-09																
36	07	-17	-11	17	03	-04	-21	-09	-16	05															
37	-15	-35	-26	-35	-39	-10	-28	-40	-09	26	07														
38	17	-06	29	24	14	11	48	19	00	34	07	03													
39	23	18	60	85	05	10	35	30	-22	18	13	-28	26												
40	18	10	43	67	06	-04	48	29	-26	14	-19	-20	38	78											
41	-38	-51	04	18	-38	-22	09	-10	-13	49	05	22	23	23	28										
42	26	20	-15	-32	07	10	16	22	31	-27	-19	-02	13	-31	-25	-33									
43	-42	-42	-05	-30	-48	36	12	08	21	06	05	16	-14	-22	-32	25	09								
44	17	34	14	-14	36	29	18	43	46	-39	05	-59	-24	-14	-26	-48	30	09							
45	-25	-13	-27	-40	09	-05	-22	11	59	04	01	-18	-28	-51	-54	-08	14	-03	47						
46	05	13	-34	-36	33	-02	-34	01	28	-26	-08	-24	-30	-41	-39	-43	09	-36	47	74					
47	66	82	16	29	81	-02	17	03	-04	-33	08	-42	14	07	00	-58	15	-49	33	-12	19				
48	02	-05	-01	-31	22	33	26	34	72	-04	-06	-23	-01	-42	-42	-22	36	08	49	69	49	08			
49	28	-06	04	48	-03	-07	-07	-18	-44	03	33	-16	18	59	49	37	-26	-23	-25	-30	-21	-06	-42		
50	36	57	-10	-01	54	-02	-13	-18	29	-57	-07	-35	-29	-24	-40	-60	09	-26	49	36	56	60	31	-23	

Principal Axis Solution

Appendix 2. (cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	h^2
1	-84	26	02	10	20	25	11	11	-02	08	-02	08	94
2	-53	-11	39	-05	-40	05	-14	-03	20	-05	01	-20	79
3	03	67	-02	-29	19	-03	-10	-18	23	22	-24	16	83
4	43	51	21	03	32	-34	21	-09	22	-02	-05	06	85
5	-84	-08	-04	-00	-03	20	06	26	24	12	-21	04	97
6	-87	-08	02	04	-14	13	-18	12	27	09	10	-03	95
7	-55	-10	20	-03	51	30	-07	09	11	11	16	-11	83
8	-31	-32	-13	41	03	-26	19	13	-28	-02	04	06	72
9	-32	-29	-40	-34	47	-06	-07	15	-14	-25	-06	-08	85
10	30	-04	-14	33	35	-12	-03	19	40	-06	-06	18	66
11	27	01	22	-05	28	-58	16	35	-12	-03	-01	-14	73
12	52	-57	-14	14	28	23	-04	-17	08	03	-17	-20	92
13	-45	-10	15	-08	-49	09	12	-15	-01	06	01	11	69
14	-72	-02	-07	-01	06	-09	-07	-02	-13	07	-20	30	77
15	-79	06	-09	-18	30	13	-25	00	03	-21	07	02	92
16	-41	30	11	-33	22	15	18	-01	-17	-04	37	-14	72
17	06	13	15	-64	24	-29	16	-24	00	-14	-09	08	72
18	-87	-17	-09	-14	02	02	-03	23	02	-07	-02	-04	92
19	-81	-32	03	-13	-17	-22	-04	01	-14	-16	-03	03	93
20	56	23	-16	-18	03	34	-27	-06	-36	05	-03	-09	79
21	14	03	32	-57	25	09	-32	02	-15	28	-11	15	80
22	-10	-07	-24	-26	18	29	29	-09	-10	-10	-37	-12	57
23	54	-56	-10	-20	-00	15	-12	00	20	-27	07	-08	85
24	16	-72	-09	29	32	12	07	-27	05	09	09	22	94
25	38	36	-19	30	01	06	-42	14	-06	-30	-21	03	73
26	59	22	-15	-53	-01	17	25	-08	11	01	-07	01	81
27	72	08	-08	-20	-39	15	-06	31	12	10	08	-04	88
28	34	52	36	18	-04	08	-03	25	-30	-14	-14	-22	78
29	36	72	-12	31	09	11	-17	15	17	20	07	-19	94
30	74	-02	-11	-16	-04	16	27	29	-03	14	10	23	86
31	14	06	65	-19	04	05	-40	-13	-22	19	20	10	80
32	34	42	59	01	-01	09	43	10	-06	-12	-11	05	88
33	31	12	57	26	14	15	-26	-03	05	-18	-06	27	73
34	26	-40	62	11	14	27	09	05	-02	18	-25	-26	88
35	-48	26	07	43	22	28	01	24	-08	-11	12	12	71
36	-04	11	-23	-26	77	-20	-14	23	06	10	-00	-02	85
37	-68	-08	-09	-35	-10	22	-02	05	-07	16	-26	-03	75
38	-04	42	16	-11	20	45	25	11	-13	-11	16	12	60
39	28	85	-03	22	12	03	-16	11	01	-03	-07	13	93
40	20	80	-03	25	-11	25	10	-27	-04	-14	-05	08	89
41	-56	37	04	36	22	06	26	-14	09	18	-06	-04	76
42	11	-34	32	-38	-08	31	06	-06	42	-36	08	+04	79
43	-44	-06	62	-11	05	-47	-01	-01	11	13	07	+07	85
44	65	-38	33	-03	20	-20	-18	-03	03	-16	-09	+01	83
45	13	-78	09	35	33	15	07	-06	-03	08	01	+11	92
46	42	-72	-21	14	11	11	-03	-26	-18	10	06	12	90
47	73	03	-22	-28	-10	10	04	42	04	04	14	18	91
48	28	-58	47	13	30	20	15	07	-01	-00	03	08	81
49	06	54	-34	-03	30	-02	07	-36	05	04	27	-21	76
50	65	-47	-17	-06	-18	-08	02	13	08	30	01	-10	83
Eigen-value	12.2	7.8	3.6	3.4	3.1	2.3	1.6	1.5	1.3	1.1	1.0	0.9	40.0
%	24,4	15,6	7,2	6,8	6,2	4,6	3,2	3,0	2,6	2,2	2,0	1,8	80,0

Varimax-rotated factor matrix Appendix 2. (cont.)

	1	2	3	4	5	6	h^2
1	-88	21	-07	-05	-10	23	88
2	-36	06	10	02	-68	-10	61
3	-04	57	14	-36	30	08	57
4	17	27	42	-18	55	-31	71
5	-71	05	-29	01	-37	17	76
6	-71	09	-25	09	-46	08	80
7	-70	-27	-02	-33	02	16	70
8	-30	-23	-25	42	-00	-26	45
9	-25	-18	-66	-34	19	02	68
10	08	-22	04	18	51	-07	35
11	16	-04	10	-17	31	-61	53
12	37	-72	-08	05	26	18	77
13	-20	13	-06	10	-65	02	49
14	-61	13	-31	-00	-19	-09	53
15	-74	11	-34	-27	-09	13	77
16	-41	26	-02	-44	-04	13	45
17	12	20	-09	-67	07	-29	60
18	-67	05	-46	-08	-37	00	81
19	-54	01	-44	01	-54	-27	86
20	49	08	16	-17	26	43	55
21	11	-04	13	-70	-03	-02	52
22	-06	-07	-27	-25	04	33	26
23	59	-52	-15	-12	-03	10	67
24	03	-82	-19	16	15	02	75
25	23	19	22	27	40	19	40
26	63	19	03	-43	16	27	73
27	81	11	19	-00	-05	21	75
28	12	26	66	01	18	03	54
29	11	44	42	19	55	25	78
30	70	-11	13	-10	21	20	61
31	03	-09	52	-38	-18	-16	49
32	13	15	75	-21	04	-05	65
33	01	-21	70	-04	12	-04	55
34	05	-64	49	-17	-15	-03	71
35	-68	05	19	20	12	24	61
36	-20	-02	-31	-46	63	-11	76
37	-45	17	-36	-24	-43	22	65
38	-20	17	33	-31	12	42	46
39	03	57	47	08	54	17	87
40	03	59	47	20	31	28	78
41	-71	23	11	17	15	07	63
42	18	-33	10	-40	-38	13	47
43	-43	01	18	-24	-31	-67	81
44	50	-51	25	-18	18	-35	76
45	-04	-92	-06	16	08	-03	89
46	40	-72	-24	16	10	07	78
47	76	03	02	-14	19	20	67
48	06	-81	30	-15	-02	-08	78
49	-05	42	-06	-08	53	18	51
50	73	-38	-14	12	01	-06	71
Eigen-value	9.88	6.64	5.04	3.35	4.91	2.57	32.40
%	19,8	13,2	10,1	6,7	9,82	5,1	64,8

Regression coefficients employed
in estimating factor scores (Ledaermans method)

	1	2	3	4	5	6
1	-22	-03	06	-05	04	22
2	-00	00	06	00	-12	00
3	-00	04	-00	-08	04	01
4	-02	02	04	-04	12	-14
5	-06	-01	-01	-00	-05	09
6	-06	00	00	04	-10	07
7	-09	-07	04	-12	04	09
8	-02	-01	-03	08	03	-06
9	-01	-01	-14	-10	10	00
10	-01	-01	-01	03	06	-03
11	-00	01	-01	-02	06	-15
12	01	-11	-02	-00	07	10
13	01	01	02	02	-09	02
14	-03	01	-03	01	01	-02
15	-08	-01	-06	-12	04	07
16	-02	00	01	-08	-00	03
17	02	03	-03	-15	02	-07
18	-05	01	-09	-04	-04	02
19	-02	04	-11	03	-12	-17
20	03	-00	01	-05	-00	10
21	01	-01	02	-15	-02	02
22	00	-01	-02	-04	00	05
23	05	-04	-03	-05	-03	06
24	-03	-12	-03	05	08	03
25	-00	01	01	04	03	02
26	08	03	-03	-17	-02	11
27	11	03	02	-02	-10	10
28	-01	00	09	00	-01	00
29	-03	04	06	08	11	06
30	05	-01	-00	-04	-01	06
31	-01	-02	08	-08	-04	-01
32	-01	-01	14	-06	-04	-00
33	-03	-04	11	-01	-01	00
34	-03	-11	16	-07	-06	06
35	-07	-03	05	04	03	06
36	-06	-01	-13	-17	24	-08
37	-00	01	-03	-08	-07	09
38	-02	-01	05	-07	-01	09
39	-06	09	12	07	19	04
40	-02	06	10	08	03	09
41	-07	-00	03	05	05	00
42	02	-03	04	-09	-07	06
43	-06	01	11	-09	-05	-34
44	02	-06	05	-07	03	-13
45	-11	-31	05	11	12	04
46	03	-09	-07	05	04	05
47	07	02	-13	-05	-01	06
48	-05	-15	14	-08	-02	03
49	-01	02	-04	-02	07	01
50	08	-01	-05	04	-02	-02
Scalar product to factor loadings	97	96	93	90	93	89

Estimated factor scores

Appendix 2. (cont.)

No.	Subject	Rec. Date	1	2	3	4	5	6
1	R	2.10.67	555	562	484	573	348	530
2	C	2.10.67	604	557	405	626	446	407
3	M	2.10.67	577	312	482	587	628	470
4	F	3.10.67	509	633	525	649	693	570
5	M	3.10.67	607	266	549	494	486	552
6	R	11.10.67	543	574	468	586	336	368
7	R	18.10.67	417	427	467	657	479	500
8	R	21.10.67	571	453	472	543	468	506
9	F	23.10.67	583	590	600	342	527	232
10	M	23.10.67	621	529	357	547	614	406
11	R	25.10.67	335	465	470	532	507	607
12	R	28.10.67	471	521	526	506	306	605
13	C	30.10.67	413	582	373	363	692	583
14	F	31.10.67	540	680	716	586	597	579
15	R	1.11.67	491	422	574	456	390	578
16	R	8.11.67	398	530	388	560	497	585
17	R	11.11.67	374	345	703	539	552	353
18	M	14.11.67	636	463	478	399	525	613
19	F	14.11.67	561	540	643	421	551	641
20	R	15.11.67	429	549	465	575	465	408
21	M	20.11.67	668	367	401	445	539	512
22	F	22.11.67	594	585	594	423	402	559
23	C	27.11.67	457	557	333	353	430	510
24	C	4.12.67	379	507	550	431	528	404
25	C	18.12.67	366	486	478	307	495	422

37 x 37 Correlation Matrix

Appendix 3.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1																									
2	-02																								
3	01	02																							
4	01	-01	02																						
5	02	-00	02	-01																					
6	01	01	-02	03	01																				
7	-87	25	-09	-14	-28	17																			
8	26	39	36	-38	31	-41	-27																		
9	-79	11	-32	03	-41	09	84	-45																	
10	-17	-67	-46	-06	40	-11	-07	-35	07																
11	-70	13	-29	02	-39	13	72	-37	81	-01															
12	-47	-07	-56	-12	-52	-24	52	-36	66	16	63														
13	77	19	31	-02	22	27	-62	34	-67	-31	-69	-73													
14	03	-27	73	-29	17	-08	-24	34	-34	03	-25	-42	24												
15	-12	65	43	15	40	28	15	33	-16	-49	-08	-48	-24	08											
16	01	-14	27	-41	-27	-71	-05	42	-03	-05	-17	18	-13	30	-33										
17	-20	-24	-17	-33	02	08	19	-21	21	29	14	23	-32	04	-17	05									
18	72	-51	-10	08	13	-06	-77	-03	-59	30	-55	-41	46	06	-51	-01	-08								
19	07	-30	31	49	-14	11	-17	-22	-16	-09	-16	-16	-02	14	-06	-08	-35	14							
20	-85	32	01	-23	-03	-12	88	07	72	-03	59	41	-59	-07	26	14	19	-82	-28						
21	69	-20	06	-19	30	34	-67	10	-65	10	-64	-51	70	26	-00	-08	14	53	-09	-70					
22	-36	49	03	-59	35	10	46	43	18	-10	07	-01	-02	07	46	06	29	-57	-49	63	-02				
23	24	40	-07	56	-48	-22	-14	-13	02	-51	13	12	01	-41	03	-08	-49	05	27	-25	-33	-53			
24	-73	21	-28	-02	-49	06	85	-34	97	-08	82	65	-63	-36	-13	01	15	-59	-20	69	-67	19	12		
25	-46	-33	-65	-20	-33	-19	43	-44	60	49	58	93	-74	-33	-61	14	33	-24	-19	34	-37	-02	-13	54	

Appendix 3. (cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	69	11	53	-06	05	14	-57	37	-61	-36	-63	-69	92	49	16	11	-25	40	04	-52	61	-07	00	-56	-72
27	-01	63	50	20	28	19	05	35	-23	-57	-14	-48	25	11	97	-23	-20	-47	-00	16	-00	34	16	-18	-65
28	-86	18	-22	-05	-36	13	95	-39	97	01	80	62	-68	-31	-02	-04	21	-70	-17	82	-69	32	-05	95	55
29	-86	-06	-39	-06	-23	09	85	-49	93	34	81	66	-77	-28	-20	-08	29	-55	-19	74	-63	23	-19	87	71
30	65	06	54	-12	25	19	-61	42	-69	-25	-67	-78	93	59	23	01	-25	41	03	-52	68	01	-15	-66	-75
31	-27	-03	-37	-20	-56	-26	34	-20	46	00	42	89	-45	-22	-46	31	19	-39	-13	28	-29	05	09	46	79
32	-77	16	-48	-07	-27	06	83	-38	84	11	76	77	-80	-48	-09	-15	18	-62	-13	70	-69	27	04	83	71
33	-76	-06	-25	06	10	22	72	-42	74	39	61	21	-57	-23	04	-25	20	-35	-18	64	-51	20	-24	67	32
34	-14	64	49	05	37	16	16	41	-16	-50	-11	-46	20	15	98	-14	-09	-55	-11	32	-01	52	-03	-12	-60
35	-63	-03	-45	-25	-46	-12	68	-32	81	20	72	92	-67	-24	-41	16	25	-53	-28	61	-52	19	-09	78	88
36	08	56	52	16	44	21	-08	41	-35	-48	-29	-65	36	18	95	-22	-16	-31	00	06	18	36	03	-32	-76
37	36	-16	-17	38	31	-20	-49	-03	-39	19	-32	-08	18	-21	-06	-21	-28	35	09	-40	14	-31	23	-44	-03

	26	27	28	29	30	31	32	33	34	35	36	37
26												
27	22											
28	-62	-11										
29	-73	-31	94									
30	96	26	-68	-75								
31	-38	-42	42	41	-47							
32	-84	-18	87	86	-85	52						
33	-59	-10	76	84	-57	-14	63					
34	17	97	-01	-20	23	-40	-12	01				
35	-59	-47	78	82	-65	83	80	40	-39			
36	31	96	-24	-41	38	-58	-32	-11	95	-62		
37	05	-00	-45	-35	07	-06	-24	-29	-13	-26	-01	

Principal Axis Solution

Appendix 3. (cont.)

	1	2	3	4	5	6	7	8	h^2
1	80	38	12	-17	19	-27	-06	-11	96
2	01	-69	22	-34	32	-25	-21	02	84
3	45	-43	-12	-22	-57	27	14	01	86
4	08	02	76	21	-11	22	05	12	70
5	36	-22	28	53	35	27	-07	17	77
6	05	-22	12	52	-23	-61	24	-02	82
7	-83	-46	-06	02	-17	-09	-02	01	94
8	43	-33	-35	-40	22	19	-20	02	70
9	-92	-15	08	02	-20	-14	-13	03	95
10	-22	51	-33	57	12	25	-02	14	83
11	-82	-15	16	00	-13	-11	01	-01	75
12	-84	31	04	-31	21	-05	21	04	99
13	85	-05	-03	-05	-03	-43	-16	21	98
14	39	-10	-51	-09	-50	23	18	13	78
15	28	-92	14	12	15	02	14	04	100
16	-03	17	-44	-63	-12	34	-13	-15	79
17	-27	08	-46	20	07	-12	21	-34	51
18	57	69	04	20	-04	-02	-26	-13	93
19	17	14	43	04	-41	27	24	04	54
20	-72	-56	-26	-07	-00	17	-12	11	95
21	69	23	-29	20	09	-37	19	-08	83
22	-18	-61	-56	-01	29	-15	-04	05	82
23	04	04	79	-39	04	01	-12	-05	81
24	-89	-20	11	-12	-19	-19	-21	-04	97
25	-81	47	-14	-04	20	00	19	08	98
26	81	-04	-13	-23	-30	-32	-11	18	96
27	35	-87	22	-02	12	08	19	-04	98
28	-92	-30	02	02	-19	-13	-09	02	99
29	-95	-08	-08	22	-13	-02	-07	08	99
30	86	-09	-24	-07	-24	-26	-05	25	100
31	-61	31	-07	-53	16	-15	35	16	95
32	-93	-14	11	05	14	-04	04	01	92
33	-67	-24	-03	55	-16	08	-30	-02	93
34	27	-93	01	01	14	09	14	-05	99
35	-90	15	-17	-23	03	-15	09	20	98
36	49	-83	10	10	11	09	11	-09	98
37	30	30	31	12	38	22	05	29	57
Eigen-value	14.1	6.7	2.3	2.9	1.9	1.8	0.9	0.6	32.2
%	38,1	18,1	6,2	7,8	5,1	4,9	2,4	1,6	87,0

Varimax-rotated factor matrix Appendix 3. (cont.)

	1	2	3	4	5	6	h^2
1	93	08	08	04	13	-21	94
2	-09	-74	-11	-02	24	-41	80
3	17	-39	17	-15	-78	-06	84
4	-02	-11	78	18	17	08	68
5	27	-33	-21	04	05	71	74
6	-01	-11	-08	86	-06	-04	76
7	-92	-14	-20	12	-05	-13	94
8	35	-44	-29	-47	-18	-05	66
9	-91	16	-06	16	07	-20	93
10	-08	56	-16	04	12	67	81
11	-82	10	01	13	13	-20	75
12	-62	44	-12	-28	43	-30	95
13	83	-24	-09	30	-17	-22	91
14	24	-01	-16	-17	-78	13	73
15	-02	-97	-00	16	-06	09	98
16	02	20	-20	-72	-34	-19	75
17	-19	22	-47	08	-00	19	35
18	71	49	21	11	00	19	84
19	07	09	64	03	-24	03	48
20	-84	-29	-32	-18	-08	04	93
21	77	08	-29	30	-07	09	78
22	-24	-48	-73	-04	-03	07	82
23	03	-13	66	-11	31	-47	79
24	-88	10	-06	12	07	-34	92
25	-56	62	-22	-19	39	-01	94
26	75	-16	-06	16	-46	-31	92
27	06	-96	11	05	-09	-00	94
28	-96	03	-13	15	02	-18	98
29	-93	24	-16	15	08	07	98
30	78	-21	-13	18	-47	-12	94
31	-38	40	-22	-35	30	-49	80
32	-88	08	-10	03	36	-07	91
33	-77	03	-04	34	-02	37	84
34	-03	-97	-09	01	-14	08	97
35	-74	40	-31	-14	21	-29	94
36	20	-93	04	10	-15	14	96
37	38	04	31	-12	41	24	48
Eigen-value	12.7	6.8	3.2	2.4	3.0	2.6	30.7
%	34,3	18,4	8,6	6,5	8,1	7,0	83,0

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